ORIGINAL ARTICLE

Non-fatal occupational injuries in British agriculture

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Objectives: To investigate the incidence, nature and determinants of non-fatal occupational injuries in British agriculture.

Methods: As part of a postal survey, data on lifetime histories of work in agriculture and occupational accidents were obtained from men born between 1933 and 1977 and residing in three rural areas of England and Wales. Incidence rates for different categories of accident were compared with those derived from statutory reporting. Associations with risk factors were explored by Poisson regression, and summarised by incidence rate ratios (IRRs).

Results: Of the 10 765 responders (response rate = 31%), 3238 (30%) reported at least one occupational accident at the ages of 14–64 years, leading to absence from work for ≥3 days, including 1492 accidents that could be linked to a specific job listed in the history of agricultural work. The reported incidence of injuries in agriculture was markedly higher than that derived from statutory reporting, particularly for self-employed farmers. During 1996–2003, the highest rates of agricultural accidents were from handling, lifting or carrying (4.9/1000 person-years), falls from a height (4.6/1000 person-years) and injury by animals (3.4/1000 person-years). After adjustment for calendar period and age, the risk of accidents was elevated in men who had only recently entered agricultural work (IRR 3.7, 95% CI 2.7 to 5.1 for men who had worked in agriculture for up to 1 year relative to those who had entered the industry >25 years earlier), and in those who carried out forestry (IRR 1.7, 95% CI 1.5 to 1.9).

Conclusion: Our findings confirm the substantial underascertainment of serious accidental injuries in agriculture through statutory reporting, particularly for the self-employed. The risk of accidents is highest in new recruits to the industry and in those undertaking forestry, and these groups should be a target for further preventive action.

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Although much has been done in developed countries to improve safety in the workplace, accidental injury remains an important cause of morbidity and mortality, particularly in certain industries. In Britain, statistics on occupational accidents are available from notifications to the Health and Safety Executive under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR). Among other things, RIDDOR requires employers to report all accidents in the workplace that cause death, specified serious injuries such as fractures and amputations, or absence from work for longer than three working days. The agricultural industry (farming, forestry and horticulture) has one of the highest rates of fatal occupational accidents nationally.[1] Rates of reported non-fatal accidents in agricultural workers are lower than in other non-service industries, but many are self-employed or work in small businesses, and there is thought to be substantial under-reporting in these groups.

Evidence for this theory is provided by the Labour Force Survey (LFS), data from which suggest that, even among agricultural employees, RIDDOR statistics underestimate rates of reportable injury by a factor of 3–5.[1] However, the number of agricultural workers included in the LFS each year is relatively small, limiting the more detailed conclusions that can be drawn.

To find out more about the incidence, nature and determinants of non-fatal occupational injuries in agricultural workers, we analysed data from a survey of health and work in three rural populations of England and Wales.

METHOD

The study population comprised men born during 1933–77, who were residing in three defined rural areas of England and Wales (in north Devon, the Welsh Borders and South

Lincolnshire) that were known to have a high prevalence of employment in agriculture. Members of the study population (n = 34 486) were identified from general practice age–sex registers held by local health authorities, and each was sent a postal questionnaire, followed if necessary by a reminder after 10–16 weeks. To protect the confidentiality of the participants, the mailing was carried out by the local health authorities (or their successor organisations) on behalf of the study team and subjects were identified only by a serial number.

The questionnaire addressed many different aspects of work and health, and among other things, collected data on lifetime history of paid work in agriculture (farming, forestry or horticulture) with the ages at which each job started and finished, details of the type(s) of agriculture involved, and a note of whether the subject was an employee or self-employed. It also asked about all occupational accidents (whether in agriculture or other industries) between the ages of 14 and 64 years that had led to absence from work for ≥3 days. Information was sought on the age at which each accident happened, the job in which it occurred, the circumstances of the accident, and the nature of the injuries produced.

Statisyical Analysis

Statistical analysis was carried out using STATA 8.2 SE software. Simple descriptive statistics were used to compare the relative frequency of different types of accidental injury in agricultural workers and other occupations. We then restricted all further analyses to men who had reported working in at least one agricultural job between the ages of 14 and 64 years,

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Table 1 Types of accidental injury in agricultural and other occupations

Injury	Accidents in all occupations		Accidents in agricultural workers		Accidents in other occupations	
	n*	%†	n*	%†	n*	%†
Fracture	1070	21.8	419	24.1	648	20.6
Head injury	370	7.5	104	6.0	263	8.4
Cut needing stitches	1102	22.4	446	25.6	648	20.6
Burn or scald	127	2.6	18	1.0	107	3.4
Amputation	106	2.2	46	2.6	59	1.9
Back injury	1259	25.6	381	21.9	871	27.7
Other sprain	500	10.2	156	9.0	340	10.8
Eye injury	296	6.0	85	4.9	209	6.7
Other	752	15.3	261	15.0	490	15.6
Unknown	74	1.5	35	2.0	36	1.1
All accidents	4914	100.0	1740	100.0	3142	100.0

*Information about occupation was missing for 32 accidents.
†Percentage of all accidents in the occupational category. Some accidents resulted in a combination of several injuries, and therefore percentages total to >100.

and to accidents that could be linked to a specific job listed in the lifetime history of agricultural work. Person-years calculations were used to derive incidence rates for different categories of accident during the period from January 1996 to March 2003 (the person-years at risk being calculated from each subject's history of agricultural work), and the rates were compared with those for non-fatal major and ''over three day'' injuries in farming, forestry and horticulture nationally during approximately the same period (April 1996–March 2003) derived from RIDDOR reports. Data on the latter were supplied to us by Health and Safety Executive, and population denominators for calculation of the rates were obtained from the Office of National Statistics.

Finally, risk factors for accidents in agricultural workers were examined by applying Poisson regression to data from the whole period covered by the working lives of the participants (1947–2004). In this analysis, data on lifetime histories of work in agriculture were again used to calculate person-years at risk. To account for possible within-subject correlation (292 men contributed data on more than one accident), the cluster option

was applied. Risk estimates were summarised as incidence rate ratios (IRRs) with associated 95% confidence intervals (CIs).

RESULTS

Questionnaires were returned by 10 765 subjects (31% of those mailed), including 3238 (30%) who reported at least one occupational accident at the ages of 14–64 years that had led to ≥3 days absence from work. The prevalence of such accidents was similar in the 7810 men who responded to the initial mailing (30%) to that in the 2955 who answered only after a reminder (31%). In all, 1025 men indicated that they had suffered >1 accident, including 60 who reported 5 accidents (the maximum number that could be described in the questionnaire).

Of the 4914 accidents that were reported in total, 1740 were to men who at the time were working in agriculture (593 entirely as employees and 900 fully self-employed). Table 1 shows the relative frequency of different categories of accidental injury in agricultural and other occupations. Overall, the most commonly reported types of trauma were

Table 2 Incidence of accidents among agricultural workers leading to ≥3 days absence from work during 1996–2003 and comparative data from Reporting of Injuries, Diseases and Dangerous Occurrences Regulations for the same period

Type of accident	All agricultural workers			Agricultural employees			Self-employed agricultural workers		
	Accidents (n)	Incidence*	Incidence from RIDDOR†	Accidents (n)	Incidence*	Incidence from RIDDOR†	Accidents (n)	Incidence*	Incidence from RIDDOR†
Contact with moving machinery or material being machined	41	2.9	0.41	11	2.3	0.64	30	3.3	0.10
Hit by a moving, flying or falling object	39	2.8	0.78	17	3.4	1.23	21	2.3	0.15
Hit by a moving vehicle	9	0.7	0.14	2	0.4	0.22	6	0.7	0.03
Hit something fixed or stationary	15	1.1	0.21	5	1.1	0.34	10	1.1	0.02
Injured while handling, lifting or carrying	70	4.9	0.99	31	6.2	1.67	38	4.2	0.04
Slipped, tripped or fell on the same level	36	2.6	0.77	15	3.1	1.30	19	2.2	0.04
Fell from a height	65	4.6	0.56	16	3.3	0.89	49	5.3	0.11
Exposed to, or in contact with, a harmful substance	5	0.4	0.10	1	0.2	0.17	4	0.5	0.01
Injured by an animal	47	3.4	0.34	16	3.4	0.54	31	3.5	0.06
Other	6	0.5	0.24	4	0.9	0.39	2	0.2	0.05
Unknown	30	2.2	0.02	9	1.9	0.02	20	2.2	0.00
All accidents	363	19.5	4.58	127	20.2	7.41	230	18.9	0.60

RIDDOR, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations.
*Incidence per 1000 person-years.
†Incidence of major and ''over three day'' injuries per 1000 person-years in farming, forestry and horticulture from RIDDOR statistics.

Table 3 Risk of accidents among agricultural workers leading to ≥3 days absence from work by age, calendar period, employment status, time since starting agricultural work and type of agricultural work

Risk factor	Accidents (n)	Incidence*	IRR† (95% CI)
Calendar period			
1947–54	11	7.8	0.2 (0.1 to 0.4)
1955–59	35	10.4	0.3 (0.2 to 0.5)
1960–64	51	9.1	0.3 (0.2 to 0.4)
1965–69	86	12.2	0.4 (0.3 to 0.5)
1970–74	110	12.9	0.4 (0.3 to 0.6)
1975–79	159	15.0	0.5 (0.4 to 0.7)
1980–84	184	14.6	0.5 (0.4 to 0.7)
1985–89	213	15.4	0.6 (0.5 to 0.7)
1990–94	240	16.9	0.7 (0.6 to 0.9)
1995–99	242	17.4	0.8 (0.6 to 0.9)
2000–04	161	21.3	1
Age (years)			
14–19	162	13.4	1
20–24	221	15.3	1.5 (1.2 to 2.0)
25–29	240	17.1	1.6 (1.2 to 2.2)
30–34	219	16.6	1.5 (1.1 to 2.0)
35–39	169	14.1	1.1 (0.8 to 1.6)
40–44	166	15.8	1.5 (1.1 to 2.0)
45–49	116	13.4	1.3 (0.9 to 1.8)
50–54	106	15.5	1.4 (1.0 to 2.1)
55–59	64	13.5	1.1 (0.8 to 1.7)
60–64	29	13.0	1.1 (0.6 to 1.7)
Employment status			
Self-employed	890	14.5	1
Employee	582	16.1	1.1 (1.0 to 1.3)
Both/unknown	20	20.3	1.4 (0.8 to 2.3)
Years since started agricultural work			
≤1	116	25.5	3.7 (2.8 to 5.0)
2–3	104	12.9	1.8 (1.3 to 2.4)
4–5	102	14.0	1.6 (1.2 to 2.1)
6–10	236	14.5	1.3 (1.0 to 1.7)
11–15	236	16.4	1.4 (1.0 to 1.8)
16–20	196	15.7	1.3 (1.0 to 1.8)
21–25	165	15.6	1.4 (1.1 to 1.8)
>25	337	13.4	1
Type of agricultural work‡			
Beef	1132	16.1	1.3 (1.1 to 1.6)
Dairy	638	15.2	1.0 (0.9 to 1.1)
Sheep	1078	15.9	1.1 (1.0 to 1.3)
Pigs	457	15.2	1.1 (0.9 to 1.3)
Poultry	398	14.1	0.9 (0.7 to 1.0)
Cereals	819	16.4	1.3 (1.1 to 1.4)
Vegetables	315	15.3	1.0 (0.9 to 1.2)
Fruit	90	17.4	1.1 (0.8 to 1.4)
Forestry	357	22.6	1.7 (1.4 to 1.9)
Other	130	13.7	0.9 (0.7 to 1.1)

IRR, incidence rate ratio.
* Incidence per 1000 person-years.
† Mutually adjusted IRRs.
‡Risk estimates are for men engaged in a specified type of agricultural work relative to other agricultural workers who were not. Many jobs involved several types of agricultural work.

rates of accidents reported in our study were from handling, lifting or carrying (4.9/1000 person-years), falls from a height (4.6/1000 person-years), and injury by an animal (3.4/1000 person-years). Rates were broadly similar in employees and self-employed agricultural workers, except that injuries while handling, lifting or carrying tended to be rather more common in the former (6.2 vs 4.2/1000 person-years). The incidence of accidents reported in our study was 4.3 times that from RIDDOR reports. The discrepancy was greatest for the self-employed (a ratio of 31.5), but was also apparent for agricultural employees (ratio = 2.7). For employees, it was largest for injury by animals (ratio = 6.3), whereas the most marked difference in the self-employed was for injury while lifting and handling (ratio = 107).

Table 3 gives IRRs for accidents in agricultural workers in relation to a number of potential risk factors. The frequency of reported accidents increased progressively over the period covered by the study (IRR 0.2, 95% CI 0.1 to 0.4 for 1947–54 as compared with 2000–04), but after allowance for this trend, risk varied little with age, and was only slightly higher in employees compared with the self-employed (IRR 1.1, 95% CI 1.0 to 1.2). There was, however, a markedly higher risk of accidents in individuals who had only recently entered agricultural work (IRR 3.7, 95% CI 2.7 to 5.1 for men who had worked in agriculture for up to 1 year as compared with those who had entered the industry >25 years earlier). In addition, there was a substantial increase in risk among men who were engaged in forestry (IRR 1.7, 95% CI 1.5 to 1.9).

When similar analyses were carried out for specific types of accidents (supplementary table A, available at http://oem.bmj-journals.com/supplemental), the increased risk in foresters was significant for each of: contact with moving machinery or material being machined (IRR 2.5); hit by a moving, flying or falling object (IRR 2.4); hit by a moving vehicle or hit something fixed or stationary (IRR 2.1); injured while handling, lifting or carrying (IRR 1.9); and slipped, tripped or fell on the same level (IRR 2.2). However, there was no marked increase in risk in foresters for falls from a height or injury by animals. As might be expected, the highest risks of injury by animals were in beef (IRR 3.8, 95% CI 1.9 to 7.8) and dairy (IRR 1.8, 95% CI 1.2 to 2.6) farming.

DISCUSSION

Our data confirm the substantial under-reporting of serious accidental injuries among agricultural workers under RIDDOR, the shortfall being most marked for those who are self-employed. The most frequent types of accident were from manual handling, falls and injury by animals, and the risk of accidents was highest in men who had only recently entered agricultural work and among those engaged in forestry.

In interpreting these findings, it is important to consider the potential for bias from incomplete response to the questionnaire and from errors of recall. The overall response to the questionnaire was only 31%. The reasons for this are discussed in more detail elsewhere (submitted for publication), but it seems likely that a major factor was the refusal of the ethics

back injuries (25.6%), cuts needing stitches (22.4%) and fractures (21.8%), the proportion of cuts and fractures being somewhat higher in agricultural workers than in other occupations. There were no major differences in the types of injuries sustained by employees as compared with self-employed agricultural workers (data not shown).

All further analyses were restricted to the 1492 accidents that could be linked to a specific job described in the section of the questionnaire on lifetime history of agricultural work. Table 2 shows the number and incidence of such accidents during 1996–2003 according to the type of accident and whether the subject was an employee or self-employed. For comparison, the table also presents corresponding rates for non-fatal major and "over three day" accidents derived from RIDDOR reports nationally during approximately the same period. The highest

> ## Main messages
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> - Occupational accidents occur frequently in British agricultural workers and are substantially underascertained by the statutory reporting system, especially among the self-employed.
> - Risks are particularly high in new recruits to the industry, and in those who undertake forestry.

Policy implications

- Statutory reporting schemes can be unreliable as a source of information on occupational accidents in agriculture.
- The higher risks in new recruits to agriculture and in foresters should be a particular focus for preventive action.

committee to allow the research team access to subjects' names and addresses. This meant that the mailing had to be carried out by proxy with an impersonal covering letter. Nevertheless, we think it unlikely that the low response will have caused serious bias in relation to the questions examined in this paper. The questionnaire covered a wide range of topics, of which occupational accidents were just one. Moreover, the rate of reported accidents was similar for those who answered the questionnaire when first contacted and for those who responded only after a reminder, and even if the incidence of accidents in non-responding agricultural workers were much lower (which seems unlikely), this could not account for a discrepancy with RIDDOR statistics as large as that observed.

Our questions about occupational accidents were limited to injuries that had necessitated at least 3 days absence from work, which should have been relatively memorable. Nonetheless, it would not be surprising if recall were incomplete, particularly for accidents many years in the past. This may explain the apparent increase in the incidence of accidents over the course of the study period (table 3), and care was therefore taken to adjust for calendar period when examining associations with other potential risk factors.

For reasons of statistical efficiency, our survey was restricted to men, the prevalence of paid work in agriculture being much higher in men than in women. It follows that our findings cannot necessarily be extrapolated to female agricultural workers, whose occupational activities may differ substantially from those of their male counterparts.

The comparison of accident rates with those derived from RIDDOR reports (which are intended to cover all paid work other than the armed forces) was restricted to a more recent time period (1996–2003), for which recall is likely to have been more complete. It was imperfect in so far as the RIDDOR rates were for both sexes combined (population denominators could not be obtained for men and women separately, but >80% of the reported accidents were in men), and the case definitions were not identical. RIDDOR covers specified major injuries even if they do not lead to absence from work for as long as 3 days. On the other hand, an accident that did not cause one of these specified major injuries, but which led to exactly 3 days off work was reportable in our study but not under RIDDOR. These differences are unlikely to have had a major effect, however, and our estimate for the overall rate is fairly close to that derived from the LFS,[1] confirming the substantial level of under-reporting under RIDDOR, particularly for self-employed agricultural workers. Under-reporting by self-employed farmers appeared to be particularly high for manual handling accidents.

Of the potential risk factors for accidents that we examined, the two that stood out were time since first work in agriculture and work in forestry. In comparison with men who had entered agriculture >25 years earlier, the risk of serious accidental injury was almost fourfold higher with men in the first year of agricultural work (table 3). Thereafter, risk declined progressively, the main reduction being over the next 4 years. This trend could not be ascribed to a confounding effect of age, which was included as a covariate in the analytical model. It is consistent with findings from other studies of agricultural workers,[2 3] and in many other industries[4–8] that rates of occupational injury are highest in inexperienced workers.

One reason for a higher risk of accidents soon after first entering a job could be that those who are most prone to accidents selectively move on to other work at an earlier stage. In support of this, there is evidence that when followed up long-term, workers employed in two industries (production of man-made mineral fibres and of glass-reinforced plastics) for <1 month had significantly higher mortality from injury and poisoning than longer-term employees of the same companies.[9] However, the main explanation is likely to be that new recruits to an industry are more susceptible to accidents because they lack experience. Either way, our findings suggest that campaigns to reduce accidental injury in agriculture might usefully emphasise the special need for safety training of new workers.

Our estimate of the risk of accidents associated with forestry was for men whose job involved this type of work compared with other agricultural workers. However, some work in forestry was only part-time, the men concerned also carrying out other types of agricultural work, and in these cases, we cannot be sure that the reported accidents all occurred in the course of forestry. Normally, any resultant misclassification would be expected to obscure rather than spuriously exaggerate associations with forestry. Moreover, the excess risk that we observed was restricted to the types of accident that might plausibly be expected to occur in forestry. However, to check for bias, we repeated the analysis specifically for full-time forestry workers, and the risk remained higher (IRR 1.8, 95% CI 1.5 to 2.3).

In conclusion, our results confirm the relatively high rate of occupational accidents among agricultural workers (both employees and self-employed), and point to particularly high risks in those new to the industry, and those engaged in forestry. Further efforts are needed to address this continuing, important source of morbidity.

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